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SMD Operations Procedures Manual

8.1.3.12 OPERATION OF THE MAGCOOL TEST AND MEASURE SYSTEM FOR BAY D AND E

Text Pages 1 through 9

Hand Processed Changes

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Division Head

Date

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8.1.3.12 Operation of the MAGCOOL Test and Measure System for Bay D and E

1.0 Purpose

This procedure provides instruction for STARTUP/SHUTDOWN and operation of Test and Measure System in Bay D or E. T-M Operation provides cooling to the magnet for quenching and field measurement. It establishes flow control for current leads and handling of cold helium after quench. (Note: MAGCOOL is originally designed for forced flow cooling for test Bays A through E. Since 2000, Bay A is modified as part of liquefaction operation for vertical test and Bay B is disabled. In 2002, Bay C was modified for testing LHC magnets D2, D3 and D4 using either forced flow cooling or liquid cooled.)

2.0 Responsibilities and Scope

Operator is responsible for STARTUP/SHUTDOWN and operation of the Test and Measure System.

3.0 Prerequisites

- 3.1 Operator shall be instructed by a supervisor or designee.
- 3.2 Instruction shall include the MYCOM compressor, CRT, Low Temp and the MAGCOOL Refrigerator (MODEL 4000).

4.0 Precautions

- 4.1 Hearing protection shall be worn in the Compressor Rooms.
- 4.2 Clear unauthorized personnel in the vicinity of operational equipment before startup.

5.0 Procedure

- 5.1 The Mycom compressor, MAGCOOL refrigerator and LOW TEMP must be operational.
- 5.2 Since year 2000, all tests involved only one test Bay. There is no magnet in other Bays. Once Cooldown I completed, the operator can switch to Test and Measure which will cool the magnet from 100 to 4.5 K for test.

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- 5.3 For testing magnet in Bay D or E, use screen display page D7 to monitor process condition and control (as shown in Figure 1). The flow diagram consists of the Precooler, Subcooler, Cold Surge Tank, Ejector and Circulating Compressor. The Ejector is used to maintain pressure in the Subcooler to about 0.65 atm (~ 3.8 K). In the basic operation (without using Cold Circulator), high pressure helium from HEUB refrigerator (cooled by Precooler and Subcooler to approximately 3.9 K) is used to cool the magnet to ~ 4.2 K. After cooling the magnet, helium passes through Cold Surge Tank and is used as inlet to the Ejector. Three controllers for 1) loop pressure in circulator mode, 2) liquid level in Subcooler and, 3) by-pass flow through AOV14, are given in the lower left corner. Trend of temperature returned from the magnet is given in the lower right corner.

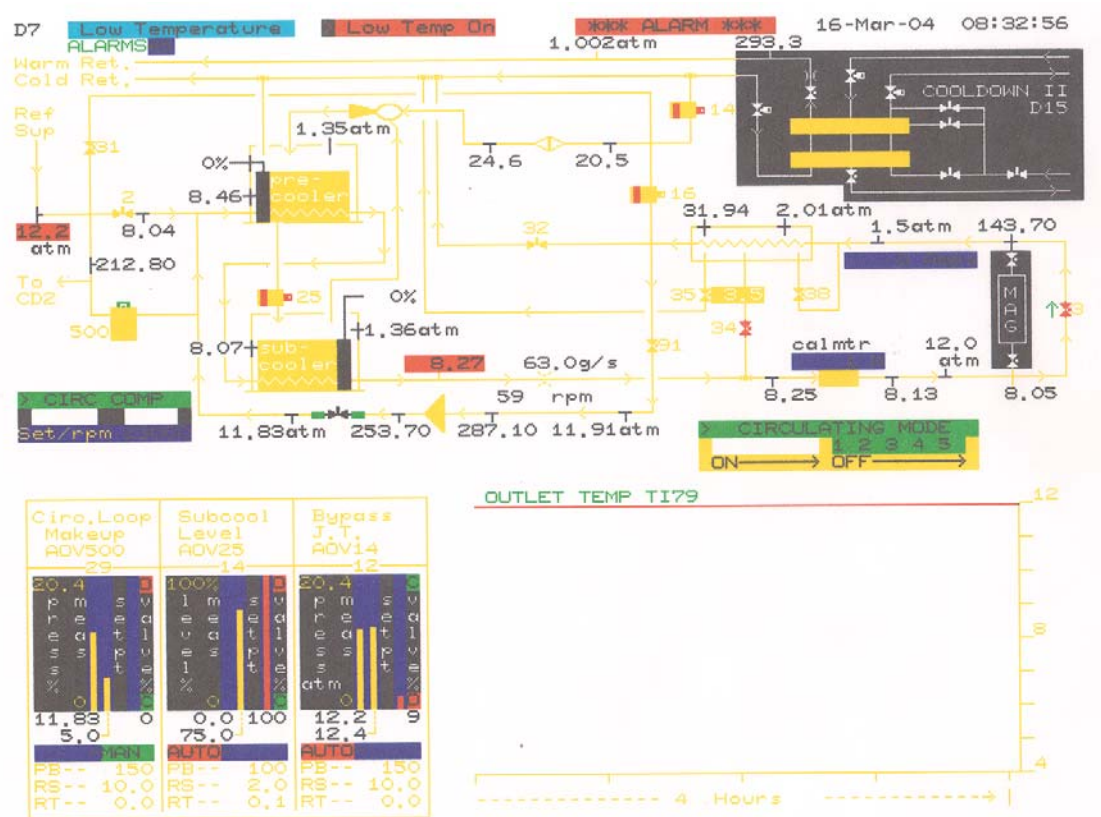


Figure 1. Display of control page D7 for Test and Measure in Bay D and E

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- 5.4 Refer to OPM 8.1.3.13 Operation of MAGCOOL Refrigerator, make sure refrigerator by-pass is set to AUTO on control page D23. This allows cold helium return from the magnet to appropriate by-pass valve in HEUB.
- 5.5 Refer to OPM 8.1.3.13 Operation of MAGCOOL Refrigerator, bring cursor to **TEST and MEASURE**. Press **OPEN or ON** on page D9. Cold gas will now flow from the refrigerator through Low Temp Cold Box and magnet. The cooldown process can be monitored on display D7.
- 5.6 Supposed multiple test Bays are used and Cooldown 2 is used. The operator needs to remove magnet from CD2 and Install into Test & Measure when the **DONE** flag appears for CD2 on pg. D9 (Note: Cooldown 2 will not function without Low Temp at operating parameters).
 - 5.6.1 Display pg. D9 bring cursor to CD2 press **CLOSE or OFF**.
 - 5.6.2 Bring cursor to **TEST and MEASURE**, press **OPEN or ON**. Cold gas will now flow from the refrigerator through the low temp cold box and magnet.
- 5.7 Magnet will stay in test and measure until operator is through testing.
- 5.8 The magnet can be run in 2 modes: Ejector and Circulator.
- 5.9 In Ejector Mode, helium flows through the magnet to the ejector. This mode is completely controlled by Crisp computer control program.
- 5.10 In Circulating mode, a circulator is used to provide helium flow through the magnet.
- 5.11 To install in circulator mode **DISPLAY** page D7. For Circulator Mode, proceed the following steps.
 - 5.11.1 Turn power on to circulator control panel. Enter in Logbook.
 - 5.11.2 Crack open MOV33. When pressure on both sides of circulator are the same as the refrigerator supply pressure, open MOV33 wide. At this time display pg D7 cursor to valve MOV33, press **OPEN or ON** valve turns **RED**. Enter in Logbook.

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- 5.11.3 Crack open the ¼ inch Hoke valve on the LOW TEMP BOX which permits, the cooldown of the circulator and its piping. Enter in Logbook.
- 5.11.4 When the circulator is at 20⁰ K or less, close the cooldown valve and start the circulator by:
 - 5.11.4.1 DOV 31 will open to cool connected piping. Enter in Logbook.
 - 5.11.4.2 A red flag will be shown on pg. **D7 MOV 33 OPEN**.
 - 5.11.4.3 Move cursor to flag and press **OPEN or ON**. Flag will disappear.
 - 5.11.4.4 DOV 2 will close.
 - 5.11.4.5 Set controller 29 at 2 atms. below loop pressure. Valve 35 will open and close to vent loop pressure to 2 atms. above value set on Controller #29.
 - 5.11.4.6 As the loop pressure decreases, lower the pressure setting on Controller #29 until 5 atms loop pressure is reached. By this time, circulator should have started.

NOTE *The circulator mode should be started only if the low temp system is at 10⁰K or less.*

- 5.11.5 When liquid level appears in the sub-cooler and the liquid level in the pre-cooler is about 80% full and TI 1005 (at refrigerator) reads 20⁰K or colder, one expansion engine may be stopped and the other slowed to ~ 150 rpm. At this time, the last by-pass valve D20 in the refrigerator has been opened. Proceed to set cold engine by-pass as below.
 - 5.11.5.1 At the refrigerator control panel, set TC-1 at 10⁰K in **AUTO**.
 - 5.11.5.2 Display pg. D21, bring cursor to valve 24, press **OPEN or ON**.

NOTE: *This procedure allows some cold return helium to bypass the heat exchangers in the refrigerator if the discharge temperature of expander falls to 10 K.*

- 5.12 This test and measure system is only for stands D and E.

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- 5.13 Installing Test and Measure will activate your LEAD FLOW CONTROLLERS in control page D17 as shown in Figure 2.

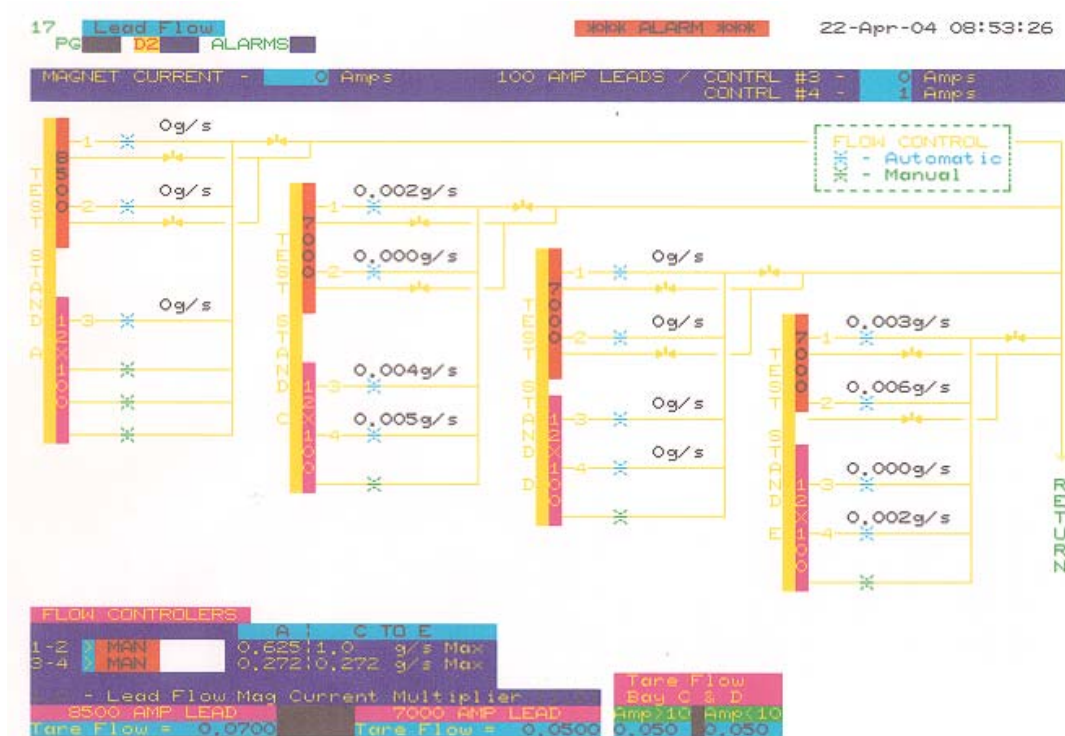


Figure 2. Display of control page D17 for Lead Flow Controllers in Bay D and E.

- 5.13.1 The bay in Test and Measure, lead flows of the 7500 A leads are calculated as a function of currents. Lead flows are controlled by the HASTINGS flow controllers from the computer.
- 5.13.2 Tare flow setting .050 g/s on cool down of magnet and over night operation.
- 5.13.3 Before testing set Tare flow to .070 g/s.
- 5.13.4 Bay D and E lead flow control on page D17 select.

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- 5.13.4.1 Control on this page has a multiplier designed for fast ramping of the magnet. This feature was used for testing RHIC magnet is the past. Since 2000, fast ramping is not used. The multiplier shall be set to 1.0.
- 5.13.4.2 There is a MANUAL mode for the flow controllers. Since flow rate is calculated from ramping current. Whenever the magnet is not actually ramped, the controller shall be set to MANUAL.
- 5.13.4.3 To avoid lead quench, the 7500 A leads require sufficient flow. However, too much flow could freeze the O-rings in the warm end of the lead. The cryo operator need to follow above instruction and shall work closely with the magnet test operator to monitor the voltage and temperature of the leads.

5.14 Installing Test and Measure will activate your Quench detection system.

- 5.14.1 When a magnet quenches, the magnetic stored energy is deposited to the cooling helium instantaneously. Large amount of cold helium gas is generated at rapid rate. The operator needs to handle the transient of large amount of cold gas return to the refrigerator. The quench handling in Ejector mode is given in 5.14.2 and that in Circulator mode in 5.14.3.

5.14.2 Quench handling in Ejector Mode

- 5.14.2.1 At quench you will have a quench flag in red for 2 minutes.
 - A. This will lock out Valve DOV 35 to stop helium in the surge tank from returning to refrigerator.
 - B. It will open Valve DOV 38 to the surge tank when pressure at Low Temp indicator PI74 reaches 13.7 ATM. Note: It will open and close to hold pressure in the magnet below 13.7 ATM.
- 5.14.2.1 After quench flag in red disappears a quench mode flag will appear.
 - A. Valve DOV 38 will lock out by the CRISP computer control program.

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- B. Valve DOV 35 return to refrigerator will open and close until surge tank indicator PI75 pressure is below 3.5 ATM.
- C. COLD GAS WILL BE GOING TO THE RETURN OF THE REFRIGERATOR. STOP ENGINES TILL REFRIGERATOR STARTS TO WARM. WHEN REFRIGERATOR IS ABOUT OPERATING TEMPERATURES, START ENGINE.
- D. When surge tank pressure indicator PI75 is below 3.5 ATM the quench mode flag will disappear.

5.14.3 Quench handling in Circulator Mode

- 5.14.3.1 In the circulating mode, DOV 38 is already open. The cold surge tank is connected to the cooling loop.
- 5.14.3.2 At quench you will have a quench flag in red for 2 minutes.
 - A. Valve DOV 35 return to refrigerator will open when surge tanks pressure indicator PI75 reaches 13.7 ATM.
 - B. After quench flag in red disappears a quench mode flag will appear.
 - C. When surge tank pressure indicator PI75 and low temp indicator PI74 system is 5.0 ATM the quench mode flag will disappear.
 - D. COLD GAS WILL BE GOING TO THE RETURN OF THE REFRIGERATOR. STOP ENGINES TILL, REFRIGERATOR STARTS TO WARM, WHEN REFRIGERATOR IS ABOUT OPERATING TEMPERATURES, START ENGINE.

6.0 **Documentation**

Documentation is kept in the CRYOGENIC Logbook located in Building 902.

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7.0 References

- 7.1 Operations and Maintenance manual provided by CVI is kept in the CRYOGENIC Control Room located in Building 902.
- 7.2 An Operators Problem Guide and Operations Guide is give to all operators and a copy is kept in the CRYOGENIC Control Room located in Building 902.
- 7.3 Operator's Manual Model 4000 Helium Refrigerator for Brookhaven National Laboratory, August 1975. A copy is kept in the CRYOGENIC Control Room located in Building 902.

8.0 Attachments

None